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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
3029-72 US

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.5)
09/889843

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US00/01702	**24 January 2000**	**25 January 1999**

TITLE OF INVENTION
SELF REGULATING FLEXIBLE HEATER

APPLICANT(S) FOR DO/EO/US
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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Three (3) sheets of formal drawings

Attorney Docket No: 3029-72 US
Express Mail Label: ET025234409US

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21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS	PTO USE ONLY
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$970.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	**$840.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$690.00**		
☒ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$670.00**		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	**$96.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =		**$690.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).		**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	24 - 20 =	4	x $18.00	**$72.00**	
Independent claims	2 - 3 =	0	x $78.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
	TOTAL OF ABOVE CALCULATIONS =			**$762.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).** ☐				**$0.00**	
	SUBTOTAL =			**$762.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
	TOTAL NATIONAL FEE =			**$762.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**	
	TOTAL FEES ENCLOSED =			**$762.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$762.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees. A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **50-1145** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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REGISTRATION NUMBER

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09/889843

SELF REGULATING FLEXIBLE HEATER

Field of the Invention

The invention relates to a self-regulating flexible heater construction suited for use in automobile components but which has use in other applications, including but not limited to furniture pieces, consumer items, construction materials, and other articles. The flexible heater construction is comprised of a breathable fabric substrate to which is applied a coating of a conductive material and a coating of positive temperature coefficient ("PTC") material. The conductive material is in electrical contact with a power source. The PTC material regulates the temperature of the heater.

Within the automotive field, the present invention can be employed as a seat heater and, to provide a non-exhaustive list of other applications, as a heater for dashboards, steering wheels, stick shifts (for manual and automatic transmissions), mirrors, arm rests, and others.

Background of the Invention

Heating devices with temperature self-regulating properties are used in the automotive industry. However, such heaters are employed where flexibility of the heater is not at issue. For example, such heaters are used on mirrors located outside of the vehicle. These heaters are printed upon a rigid biaxially oriented polyester film. See, e.g. U.S. Patent nos. 4,931,627 and 4,857,711, both assigned to the assignee of the present application.

Heaters for automotive vehicle seats that are currently available offer less than adequate performance due to several undesirable attributes. Current heaters are known to build up static electricity, which damages the heater controller circuit when it is discharged. Another shortcoming is that current seat heater design, in which the heater elements are copper wire and

design creates several problems in that heating is localized to the area of the wires, creating an undesirable heating pattern where the areas in the vicinity of the wire are too hot and areas removed from the wire are too cool. Moreover, since the heating wire per se does not possess any means for regulating the temperature (that is, copper wire and the like is incapable of sensing that it has become too hot), a sophisticated temperature controller is required for regulating the temperature of the seat heater. This creates a challenging design problem for the engineer, which could be avoided if the heater construction per se was self-regulating and could increase or decrease the amount of heat produced as necessary.

Furthermore, when heating a seat in an automotive vehicle, it is evident that the seat heater construction must be flexible, durable, and able to withstand the demands of the operating environment, which include the potentially degradative effects of prolonged exposure to heat and the flow of electricity.

It would be desirable if a heater for an automotive seat were deigned so that a uniform amount of heat could be distributed over the area to be heated. Likewise it would be desirable if a seat heater could be designed in which, if desired, the amount of heat delivered to particular area could be varied as a design parameter, so that if it is deemed that certain areas should be warmer than others for a given design (or cooler, as the case may be), the heater could be constructed to accommodate this variation.

Furthermore, since the comfort of a vehicle seat is attributable to its flexibility, it would be desirable if the seat heater construction was flexible so that its presence in the seat complimented the other flexible components of the seat construction. It would be additionally desirable if the seat heater construction incorporated a flexible fabric layer. It would be highly

advantageous if the heater components could be applied to the fabric using well known printing and coating techniques, which could be used to construct a heater quickly and easily, and relatively cheaply. Also, application techniques such as printing or coating could be used to make uniform or varying applications of component materials, which could provide for the uniform distribution of heat, or if desired, variations in the amount of heat.

Positive temperature coefficient (PTC) materials exhibit variable electrical resistance with temperature. As the temperature of the material increases, the electrical resistance also increases. The resistivity of the material increases so current flow is reduced, limiting heat flow. In essence, positive temperature coefficient compositions are used to form temperature self-regulating coatings. PTC materials are known in the art. Exemplary disclosures concerning these materials can be found in U.S. Patent nos. 5,206,482 and 5,151,747, among others.

Summary of the Invention

The present invention is directed to a self regulating flexible heater, such as a heater for use in automobiles and other vehicles, in which a PTC material and conductive material are applied to a woven or non-woven fabric that is constructed of natural or synthetic fibers.

An electrical buss system of a conductive material is applied over a fabric before or after being coated with a PTC material. The conductive material is applied in an interdigitating pattern emanating from multiple buss bars. The buss bars are configured such that the heater offers uniform heating across the surface of the heater. The amount of heat generated may also be varied as a design parameter so that certain regions generate more or less heat as desired. The buss bars can be connected to the power source by a variety of interconnection devices such as fasteners, terminals conductive epoxies, to name a few of a broad range of interconnecting means

that would be within the realm of the skilled artisan. Wire connectors are attached to the terminals and the wire from the power source. Preferably, a secondary layer is applied over the heater construction, such as an adhesive layer or a breathable fabric. The breathable fabric may be one that is breathable by virtue of the material that is used, or one that is machined to be breathable, such as by needle punching.

The heater element is applied just under the external layer of the vehicle seat, preferably as close to the end user as possible. The heater element is placed on the base of the seat, or on the back of the seat, or both. Preferably, the coating of PTC material has a weight 7 to 20 lbs per ream (that is, 3300 ft.^{2}) and a surface resistivity of 2 to 10 kilo-ohms as measured by mulitimeter probes set 1 cm apart. More preferably the coating of PTC material has a surface resistivity of 3 to 8 kilo-ohms as measured by mulitimeter probes set 1 cm apart.

Suitable materials for the fabric substrate include woven and non-woven fabric constructions of material including but not limited to polyesters, polyamides, polyaramids, polyimides, polyetherketones, glass fibers, phenolics, and carbon fibers. With respect to the fabric selection process, it has been found that heater constructions having a bulk density of about 0.6 g/cm^3 or greater and a thermal diffusivity of about 0.003 cm^2/s or greater insures a desirable degree of conductivity and heat flow through the fabric. This can be achieved using multifilaments with a relatively high number of twists per inch. However, a high degree of twists, or even using high denier fibers, reduces fabric flexibility. Accordingly, the skilled artisan should strike a balance between these properties.

The heating element may comprise a coating formed from a composition of a conductive material of electrically conductive particles dispersed in a polymer matrix, and a coating of a

PTC material. In the self-regulating heater of the present invention, the heating element is in thermal communication with the component to be heated, such as the automobile seat. Preferably, the PTC material is coated onto a woven or non-woven fabric. The conductive material is applied, either before or after the PTC material is applied. The conductive material is coated onto the fabric in an interdigitating pattern of electrodes which forms an electrical buss system, which can be constructed in a variety of patterns, such as in a tapered shape (see e.g., Figure 1) , a stepped shaped, in which size varies in a step arrangement, or in a straight, or constant size over the entire construction. (see e.g., Figure 3) A trim pattern is also possible in which voids are present in the busses at preselected locations. The edges of the buss system are connected to multiple buss bars in electrical contact with a power source.

In one aspect of the present invention, the self-regulating flexible heater is a coated fabric whose construction has a bulk density of about 0.6 g/cm^3 or greater and a thermal diffusivity of about 0.003 cm^2/s.

In another aspect of the invention, an encapsulating coating, which may be a flame retardant coating, is applied over the heater elements by lamination or the or other known techniques.

Brief Description of the Drawings

Figure 1 is a top plan view showing the heater of the present invention.

Figure 2 is a top plan view of the circuit of a dual wattage self-regulating flexible heater construction.

Figure 3 is a top plan view of a self-regulating flexible heater construction having a

tapered and straight buss bar arrangement.

Detailed Description of the Preferred Embodiment

In the preferred embodiment, a polyester woven or non-woven fabric 10 of a density of about 1 to 6 ounces per square yard (more preferably, about 3.7 ounces per square yard) is coated with a PTC material 12 such as commercially available PTC coating materials, such as an ethylene-vinyl acetate co-polymer resin available as Dupont 265. Such materials are described in U.S. Patent no. 4,857,711, incorporated herein by reference. The coating is applied at a weight of 13 lb per ream (that is, 3300 ft.^{2}) and resistivity of 2 to 10 kilo-ohms (more preferably, 3 to 8 kilo-ohms) as measured by mulitimeter probes set 1 cm apart.

Prior to application of the conductive material, the fabric is fully dried. The PTC layer 12 and conductive layer 14 are applied as discreet layers in any order of application. The conductive material 14 may be formulated from polymeric resins such as vinyls, polyesters, acrylics and conductive material such as silver pigment, a silver coated copper pigment, or plated copper pigments and/or solvating materials such as organic solvents, and water-based solvents which contain the conductive material. After thorough mixing, the coating is passed through a mill to effect final dispersion. Other conductive materials may be used such as conductive woven wires fixed within the construction by conductive glues. The applicants have found that these formulations are flexible while resisting cracking when bearing a load and when stretched.

The conductive material 14 is preferably applied in an interdigitating pattern (see Fig. 1) by a screen printing method, then fully dried, thereby forming an electrical buss system. Other methods may be used to apply the conductive material, including spraying, draw down applications, web printing, or other printing methods that provide a uniform coating. The

conductive material is printed in electrode patterns which are interdigitated. Each electrode of the pattern is in electrical contact with one of a multiple of buss bars 16 and 18, with adjacent electrodes alternating their connection between buss bars 16 and 18. The buss bars are configured in a decreasingly tapered arrangement. That is the width of the buss bars gradually decreases from the terminal end (20, 22) to the free end (24, 26). This insures that the electrical resistance created by the buss bars will create a heating effect that is substantially the same as that created by the heating areas. One knowing the electrical characteristics of the PTC material, conductive material and temperature requirements can readily design heating areas of varying sizes and shapes with varying buss sizes that can deliver varying amounts of heat over the heating area. Accordingly, the entire substrate, from the center out of the periphery, including those areas beneath the buss bars, will be heated as desired with substantially no cold spots. It should be noted that while the connections to the heater construction are positioned along its edges, other configurations are possible, such as making a connections from the interior of the construction, or a combination of connections along the edges and in the interior.

Power across the heater construction can be varied by varying the spacing of the smaller busses. That is, the skilled artisan would readily appreciate that doing so would vary the power at any given location in the construction.

Figure 2 shows a circuit diagram for a self-regulating flexible heater design in accordance with the present invention which provides for a multiple wattage heater. As shown in this design, high/low settings are possible where current flows from either common to high buss arrangement or a common to low buss arrangement. Other combinations are possible based on other terminal connections

Terminals 20 and 22 are attached to the buss bars and are in communication with a power source (not shown). The terminals may be attached to the buss bars 16 and 18 by fasteners or any other means that will permit an electrical contact to be formed. A secondary protective layer, such as an encapsulating layer, may be laminated over the heater assembly 30.

When a voltage is applied across the terminals and across the electrode array, depending upon the ambient temperature and the electrical characteristics of the PTC material, current will flow through the PTC material between the electrodes, generating heat in the individual heating areas. The current flow and heating effect of the PTC material depends on its temperature which will change as the ambient temperature changes and, at a predetermined temperature of the PTC material, the resistivity of the material increases causing the material to no longer conduct current, whereby the heating areas no longer generate heat, or to produce a very low amount of heat due to a significantly reduced current flow. Accordingly, it can be seen that the heater is self- regulating in accordance with the surrounding ambient temperature.

Figure 3 depicts an alternative arrangement in which the width of the buss bars is a combination of a section where the size remains constant near the free end (24, 26), and a tapered section where the buss bars gradually decrease in size further away from the terminal end (20, 22).

The skilled artisan will readily appreciate that placing a safety switch at the terminals will prevent run away conditions during which the heat generated exceeds the upper limit that has been set in the design of the heater. The switch can be a simple on-off switch that permits the user to turn off the current flowing through the heater.

Example 1

The thermal diffusivity of five coated polyester fabric sample was determined.

The samples, identified as 1 through 5, differed in terms of the whether they are woven or non-woven, and if woven, the weave pattern, number of picks per inch, ends per inch, number of filaments in the warp and filling yarns, and twists per inch in the yarns. These fabrics were submitted as strips of coated fabric approximately 500 mm long by 70 mm wide. Samples 12.7 mm in diameter were die cut from the strips for testing.

Thermal diffusivity of the samples was measured att 10° and 100° by the laser flash method utilizing a Holometrix Microflash instrument available from Holometrix Micromet. This instrument and method conform to ASTM E1461-92, "Standard Test Method for Thermal Diffusivity of Solids by the Flash Method". The test results are given after a description of the experimental procedure.

Thermal diffusivity is related to the steady-state thermal conductivity through the equation

$$D = \frac{\lambda}{C_p \rho}$$

where D is the thermal diffusivity, λ is the thermal conductivity, C_p is the specific heat, and ρ is the density. The diffusivity is a measure of how quickly a body can change its temperature; it increases with the ability of a body to conduct heat (λ) and it decreases with the amount of heat needed to change the temperature of a body (C_p). All three quantities on the right hand side of Equation (1), as well as the thermal diffusivity, can be functions of temperature.

The measurement of the thermal diffusivity of a material is usually carried out by rapidly

heating one side of a sample and measuring the temperature rise curve on the opposite side. The time that it takes for the heat to travel through the sample and cause the temperature to rise on the rear face can be used to measure the through -plane diffusivity and calculate the through-plane thermal conductivity if the specific heat and density are known.

Through-Plane Method and Analysis

The sample is a disk with a standard diameter of 12.7 mm and a thickness ranging from about 0.1 to 3 mm. With the Holometrix Thermaflash 2200 Laser Flash system, the sample disk is aligned between a neodymium glass laser (1.06 μm wavelength, 330 μs pulse width) and an indium antimonide (InSb) IR detector in a tantalum tube furnace. A type C thermocouple in contact with the sample controls the sample and its surroundings at any temperature between 20 and 2000°C. Once the sample has been stabilized at the desired temperature, the laser is fired several times over a span of a few minutes and the necessary data is recorded for each laser "shot". The laser beam energy strikes and is absorbed by the front surface of the sample, causing a heat pulse to travel through the thickness of the sample. The resulting sample temperature rise is fairly small, ranging from about 0.5 to 2 degrees C. This temperature rise is kept in the optimum range by adjustable filters between the laser and the furnace. A lens focuses the back surface image of the sample onto the detector and the temperature rise signal vs. time is amplified and recorded with a high speed A/D converter.

Conductivity

The sample thermal conductivity can be calculated with Equation (1), after a measurement of the diffusivity as described above, and with measurements of the sample specific heat and bulk density. The bulk density is normally calculated from the measured sample volume (calculated from the measured dimensions) and mass.

Test Results

The measured values of thickness, bulk density and thermal diffusivity are given in table 1 below. The results have not been corrected for thermal expansion. The samples were coated with approximately 5 μm of graphite for thermal diffusivity testing. The second column from the right in Table 1 lists the standard deviation as a percentage of the mean diffusivity for the five to ten laser "shots" taken for each data point. The bulk density values are estimated to be accurate to within ±5%.

Table 1

Laser Flash Thermal Diffusivity Results

	Thickness @ 25°C	Bulk Density @ 25°C	Temperature Tested	Thermal Diffusivity α	Fabric Type
Sample	(mm)	(g/cm^3)	(°C)	(cm^2/s)	
1	0.288	0.634	10 100	0.00360 0.00297	B-3 Polyester
2	0.180	0.555	10 100	0.00647 0.00562	B-2 Polyester
3	0.220	0.677	10 100	0.00617 0.00505	IFC 322-222 Polyester
4	0.269	0.510	10 100	0.00242 0.00205	non-Woven Polyester
5	0.556	0.910	10 100	0.00255 0.00203	PUR Coated Polyester

Note:Thermal Diffusivities are an average of 5 readings.

Example 2

The five polyester test samples discussed in example 1 were tested to determine if they would break down when subjected to extended period of operation. The samples were coated with PTC material. After drying a silver pigment was applied on top of the PTC material. These self-regulating flexible heater constructions were subjected to a 12 volt DC potential for an extended, continuous period. Heat continued to rise in the constructions, until steady state was attained for construction nos. 1 and 3. These constructions exhibited sufficient heat resistance. Constructions 2, 4 and 5 were destroyed before reaching steady state. That is, the "failed" heater constructions burned up during testing as a result of heat generated during heater operation. It is noted that the fabrics which passed exhibited a bulk density of at least about 0.6 g/cm^3 or greater and a thermal diffusivity of at least about 0.003 cm^2/s.

Laser Flash Thermal Diffusivity Results

	Thickness @ 25°C	Bulk Density @ 25°C	Temperature Tested	Thermal Diffusivity α	Fabric Type	Heater Construction
Sample	(mm)	(g/cm^3)	(°C)	(cm^2/s)		Pass/Fail
1	0.288	0.634	10 100	0.00360 0.00297	B-3 Polyester	Barely Passed
2	0.180	0.555	10 100	0.00647 0.00562	B-2 Polyester	Failed
3	0.220	0.677	10 100	0.00617 0.00505	IFC 322-222 Polyester	Passed
4	0.269	0.510	10 100	0.00242 0.00205	non-Woven Polyester	Failed
5	0.556	0.910	10 100	0.00255 0.00203	PUR Coated Polyester	Failed

Note: Thermal Diffusivities are an average of 5 readings.

With respect to the fabric selection process, it has been found that heater constructions having a bulk density of about 0.6 g/cm^3 or greater and a thermal diffusivity of about 0.003 cm^2/s or greater insures a desirable degree of conductivity and heat flow through the fabric. This can be achieved using multifilaments with a relatively high number of twists per inch. However, a high degree of twists, or even using high denier fibers, reduces fabric flexibility. Accordingly, the skilled artisan should strike a balance between these properties.

Though described in its preferred embodiment as a seat heater for automobiles, it should be understood that the self-regulating flexible heater construction of the present invention is suited for use not only in automobile components but has use in other applications, including but not limited to furniture pieces, consumer items, construction materials, and other articles. Accordingly, the preceding disclosure should be read as providing context to the invention, and not as a limitation on the field of use thereof.

Having described the preferred construction of the invention, those skilled in the art having the benefit of the description, can readily devise other modifications and such other modifications are to be considered to be within the scope of the appended claims.

WE CLAIM:

1. A self regulating flexible heater construction for producing heat when connected to an electrical power source, comprised of:

   a flexible fabric substrate;

   a layer of a positive temperature coefficient material; and

   a layer of a conductive material.

2. The heater of claim 1 wherein the substrate is woven or non-woven fabric.

3. The heater of claim 1 wherein the layer of conductive material is applied to the layer of positive temperature coefficient material in an interdigitated pattern.

4. The heater of claim 1 wherein the layer of positive temperature coefficient material is applied to the layer of conductive material in an interdigitated pattern.

5. The heater of claim 1 wherein the density of the fabric is 1 to 6 ounces per square yard.

6. The heater of claim 1 wherein the PTC material is comprised of a polyolefin resin.

7. The heater of claim 1 wherein the coating of PTC material has a weight 7 to 20 lbs. per ream.

8. The heater of claim 1 wherein the positive temperature coefficient material has a surface

resistivity of 2 to 10 kilo-ohms as measured by multimeter probes set 1 cm apart.

9. The heater of claim 1 wherein the positive temperature coefficient material has a surface resistivity of 3 to 8 kilo-ohms as measured by multimeter probes set 1 cm apart.

10. The heater of claim 1 wherein the conductive material is formulated from a mixture of a polymeric resin selected from the group consisting of vinyls, polyesters, acrylics and a conductive material selected from the group consisting of silver pigment, a silver coated copper pigment, or plated copper pigments.

11. The heater of claim 1 wherein the conductive material is formulated from a mixture of solvating materials selected from the group consisting of organic solvents and water based solvents and a conductive material selected from the group consisting of silver pigment, a silver coated copper pigment, or plated copper pigments.

12. The heater of claim 1 wherein the conductive material is constructed of conductive wires fixed within the construction by conductive glues.

13. The heater of claim 1 wherein the first and second layers are applied to the substrate by screen printing, spraying, draw down, web printing or any other printing method capable of providing a uniform coating.

14. The heater of claim 1 further comprised of a plurality of buss bars in electrical contact

with the conductive material and an electrical power source.

15. The heater of claim 14 wherein the buss bars have a width dimension and a length dimension, and wherein the width decreases over at least a portion of its length.

16. The heater of claim 14 wherein the buss bars have a width dimension and a length dimension, and wherein the width remains constant over at least a portion of its length.

17. The heater of claim 14 wherein the buss bars have a width dimension and a length dimension, and at least one void at a preselected location along its length.

18. The heater of claim 14 wherein the buss bars have a width dimension and a length dimension, and wherein the width dimension increases step-wise over at least a portion of its length.

19. The heater of claim 14 wherein the spacing of the busses varies across the heater.

20. The heater of claim 1 further comprised of an overlayer of a laminated or sewn secondary breathable woven or non-woven fabric comprised of natural or synthetic fibers which covers the heater.

21. The heater of claim 20 wherein the overlayer is an encapsulating coating, which may be a flame retardant coating, which is applied over the heater elements.

22. The heater of claim 1 wherein the heater is incorporated within the construction of a seat for an automobile.

23. The heater of claim 1 wherein the heater has a multiple buss design providing for high and low current settings, comprised of at least a common setting buss, a low setting buss, and a high setting buss, in which current flows from either the common setting buss to high setting buss or from the common setting buss to low setting buss.

24. A self regulating flexible heater construction for producing heat when connected to an electrical power source, comprised of:

a flexible fabric substrate;

a layer of a positive temperature coefficient material; and

a layer of a conductive material, wherein the seat heater composition has a bulk density of about 0.6 g/cm^3 or greater and a thermal diffusivity of about 0.003 cm^2/s or greater.

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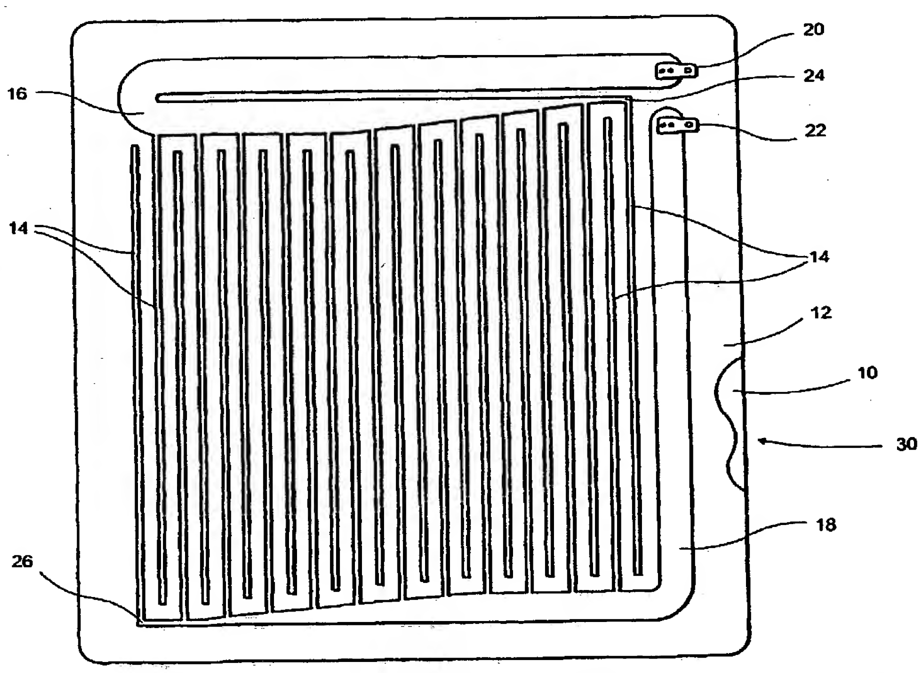
(81) Designated States *(national)*: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU,

[Continued on next page]

(54) Title: SELF REGULATING SEAT HEATER



(57) Abstract: A self-regulating flexible heater for automobiles and other vehicles which is comprised of a breathable substrate (10) to which is applied a coating (14) of a conductive material and a coating (12) of positive temperature coefficient material.

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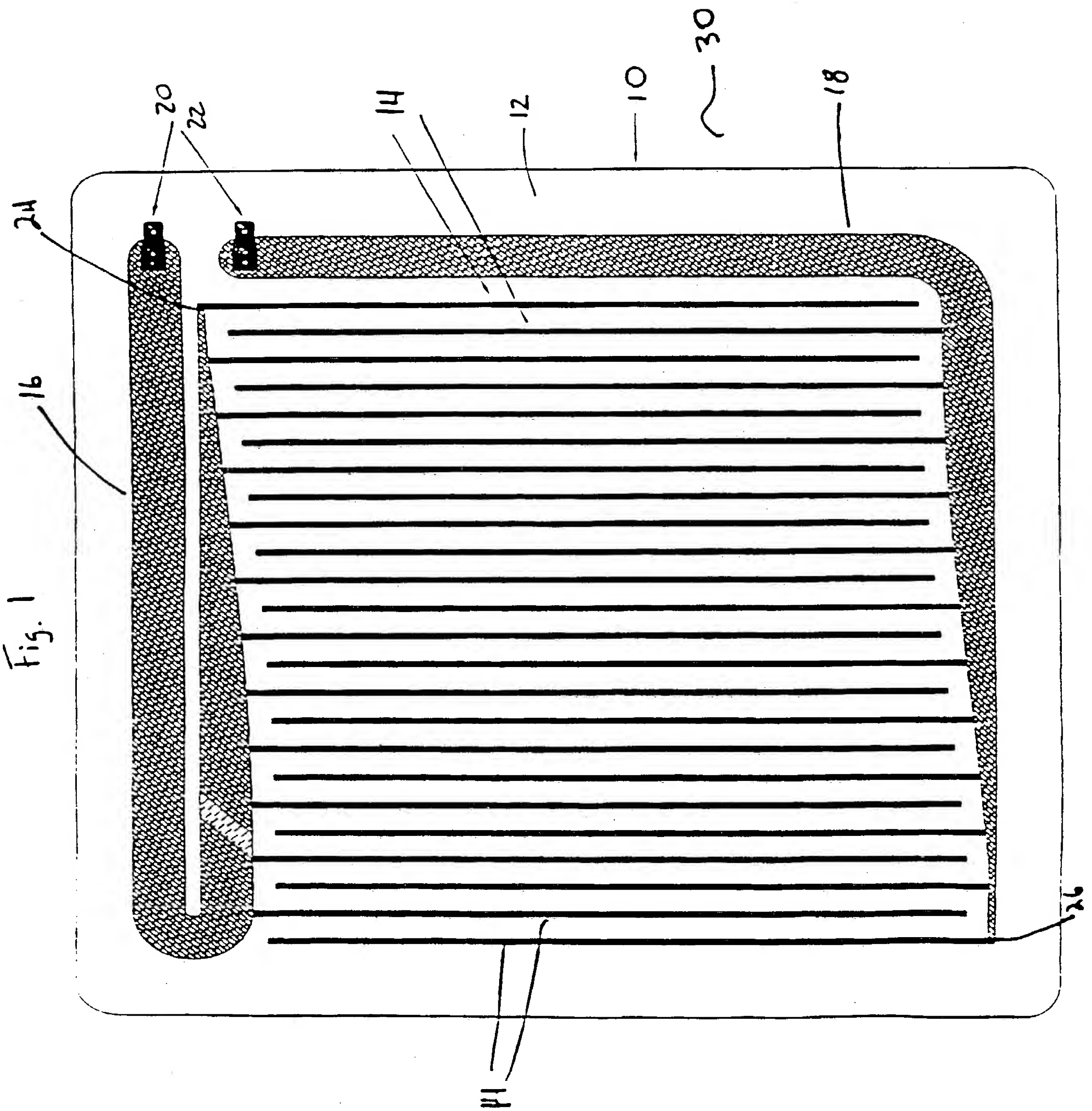


Fig. 1

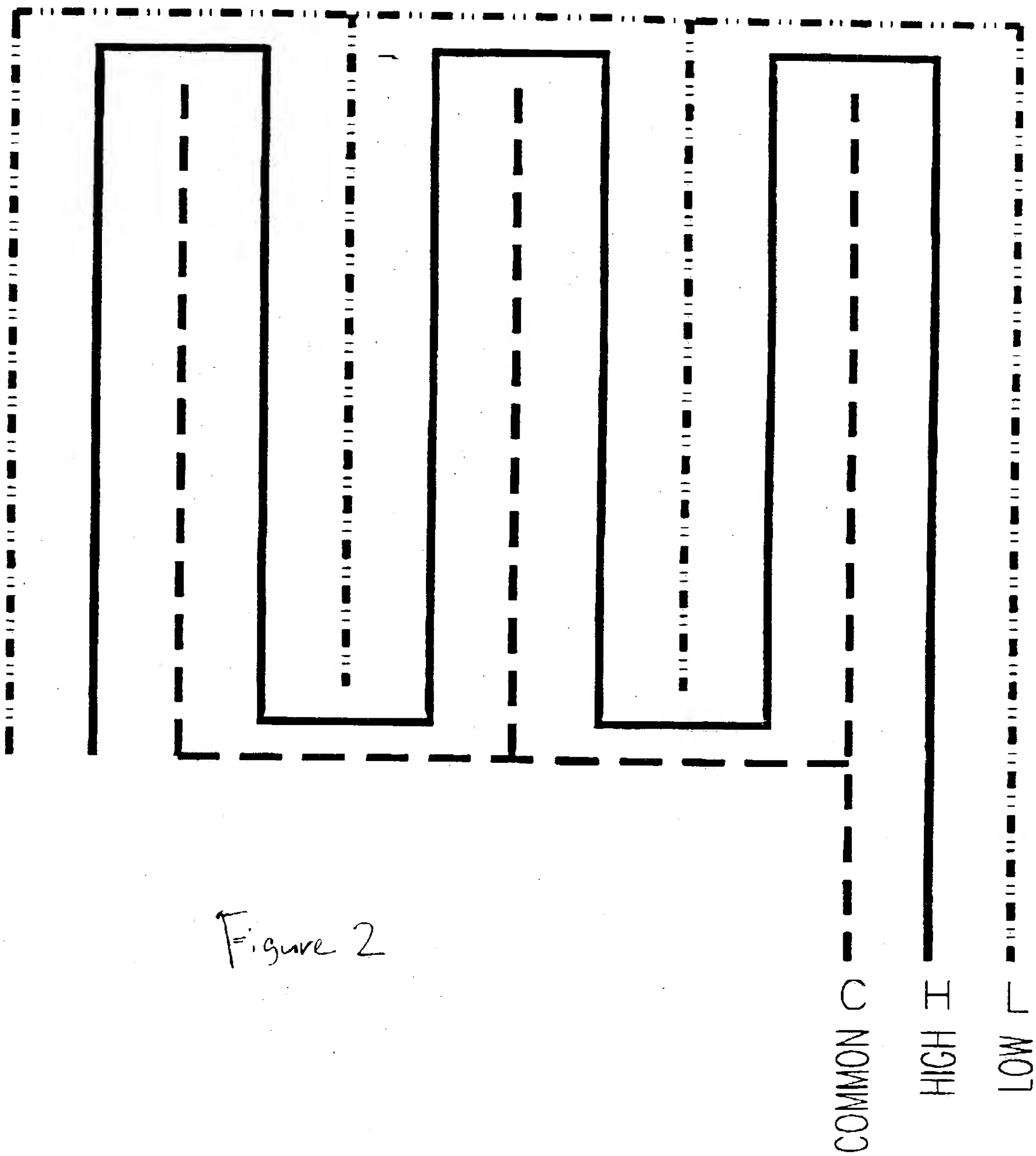
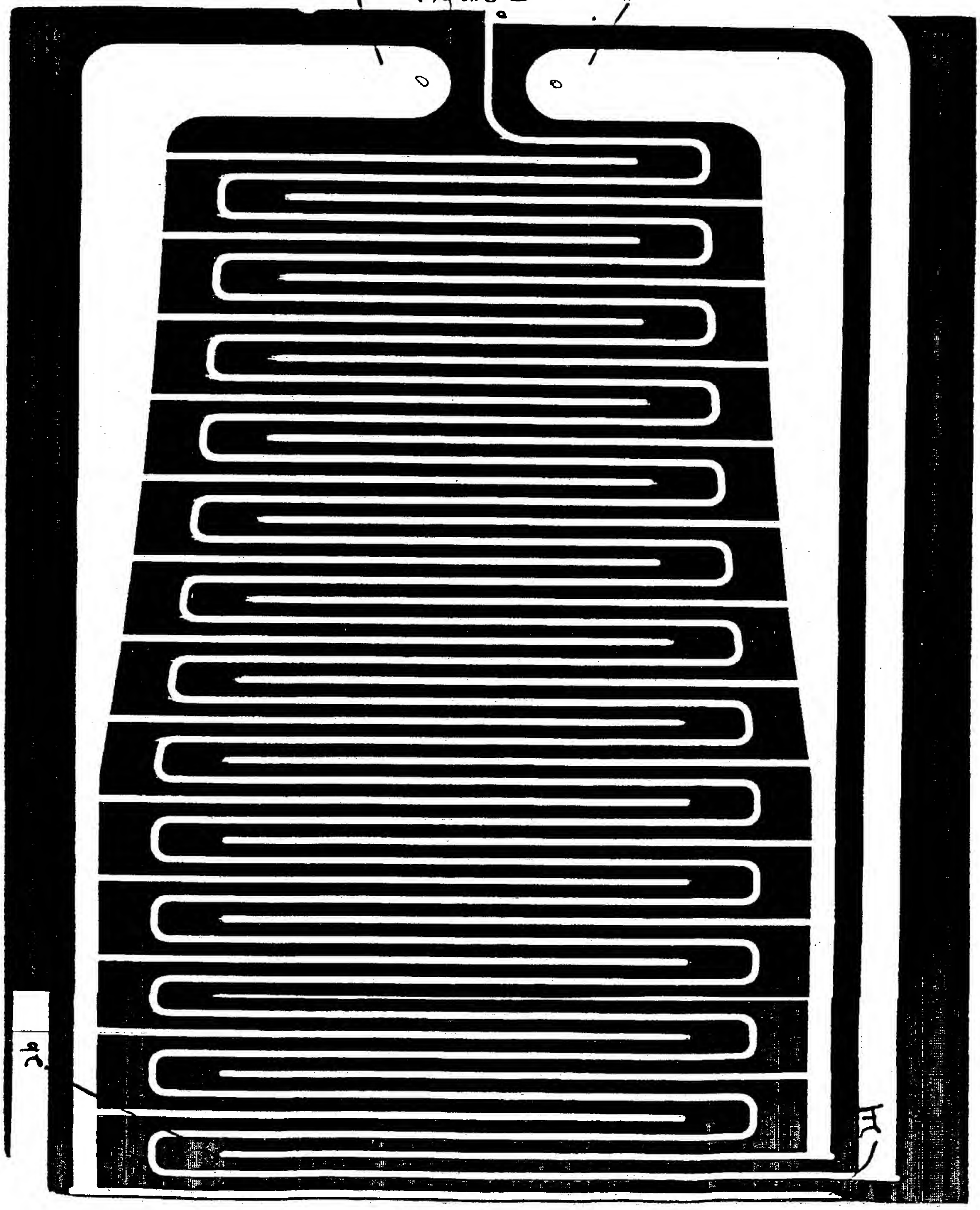


Figure 2

Figure 3



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Docket No.
3029-72

Declaration and Power of Attorney For Patent Application

English Language Declaration

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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SELF REGULATING FLEXIBLE HEATER

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on **January 24, 2000** as United States Application No. or PCT International Application Number **PCT/US00/01702, which designated the U.S.**
and was amended on **December 19, 2000 and June 4, 2001**
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

60/117,144	**January 25, 1999**
(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

Joseph C. Sullivan - Registration No. 18,720
Gerald Levy - Registration No. 24,419
Ronald R. Santucci - Registration No. 28,988
Ronald E. Brown - Registration No. 32,200
John F. Gulbin - Registration No. 33,180
Peter W. Latimer - Registration No. 46,858
Michael P. Stanley - Registration No. 47,108

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711 Third Avenue - 20th Floor
New York, NY 10017

Direct Telephone Calls to: *(name and telephone number)*

1-00

Full name of sole or first inventor **JAMES SURJAN**	
Sole or first inventor's signature James Surjan	Date 9/28/01
Residence **St. Charles, Illinois** IL.	
Citizenship **United States of America**	
Post Office Address **5N479 Farrier Point**	
St. Charles, IL 60175	

2-01
3-11

Full name of second inventor, if any **ANTOINETTE CHIOVATERO (for Fred A. ~~Dish~~ KISH - deceased)**	
Second inventor's signature Antoinette Chiovatero	Date 10/22/01
Residence **Chicago, Illinois** IL.	
Citizenship **United States of America**	
Post Office Address ~~**3819 North Francisco**~~ 3857 N. KENTON CT.	
Chicago, IL ~~60618~~ 60641	

4-00

Full name of third inventor, if any **TILAK R. VARMA**	
Third inventor's signature Tilak Varma	Date 9/21/01
Residence **Grayslake, Illinois** IL	
Citizenship **India**	
Post Office Address **18451 West Springwood Drive**	
Grayslake, Illinois 60030	

5-00

Full name of fourth inventor, if any **EDWARD BULGAJEWSKI**	
Fourth inventor's signature	Date 9/24/01
Residence **Genoa, Illinois** IL	
Citizenship **United States of America**	
Post Office Address **31164 Oakview Drive**	
Genoa, Illinois 60135	

Full name of fifth inventor, if any	
Fifth inventor's signature	Date
Residence	
Citizenship	
Post Office Address	

Full name of sixth inventor, if any	
Sixth inventor's signature	Date
Residence	
Citizenship	
Post Office Address	

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Sole or first inventor's signature James Surjan	Date 9/28/01
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Second inventor's signature Antoinette Chiovatero	Date 10/22/01
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Citizenship **United States of America**	
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Chicago, IL ~~60618~~ 60641	

Full name of third inventor, if any **TILAK R. VARMA**
Third inventor's signature Date T. R. Varma 9/21/01
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Citizenship **India**
Post Office Address **18451 West Springwood Drive**
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Full name of fourth inventor, if any **EDWARD BULGAJEWSKI**
Fourth inventor's signature Date Edward Bulgajewski 9/24/01
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Citizenship **United States of America**
Post Office Address **31164 Oakview Drive**
Genoa, Illinois 60135

Full name of fifth inventor, if any
Fifth inventor's signature Date
Residence
Citizenship
Post Office Address

Full name of sixth inventor, if any
Sixth inventor's signature Date
Residence
Citizenship
Post Office Address